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Original Investigation

Relationships between reactive agility movement time and unilateral vertical, horizontal and lateral jumps. (JSCR-08-3089 Revision 1)

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Running Head: Reactive agility and unilateral jumps

ABSTRACT

This study compared reactive agility movement time and unilateral (vertical, horizontal and lateral) jump performance and kinetics between dominant and non-dominant legs in Australian rules footballers (n = 31) to investigate the role of leg strength characteristics in reactive agility performance. Jumps involved jumping forward on one leg, then for maximum height or horizontal or lateral distance. Agility and movement time components of reactive agility were assessed using a video-based test. Correlations between each of the jumps were strong ($r = -0.62 - -0.77$) but between the jumps and agility movement time the relationships were weak ($r = -0.25 - -0.33$). Dominant leg performance was superior in reactive agility movement time (4.5%; $p = 0.04$), lateral jump distance (3%; $p = 0.008$) and lateral reactive strength index (4.4%; $p = 0.03$) compared to the non-dominant leg. However, when the subjects were divided into faster and slower performers (based on their agility movement times) the movement time was significantly quicker in the faster group ($n = 15$; 12%; $p < 0.001$), but no differences in jump performance or kinetics were observed. Therefore, although the capacity for jumps to predict agility performance appears limited, factors involved in producing superior lateral jump performance in the dominant leg may also be associated with advantages in agility performance in that leg. However, since reactive strength as measured by unilateral jumps appears to play a limited role in reactive agility performance and other factors such as skill, balance and coordination, as well as cognitive and decision-making factors, are likely to be more important.

Key Words: reactive strength, leg asymmetry, change of direction

INTRODUCTION

Well-developed agility is important for team sport success as it contributes to game-changing actions such as making or evading tackles (28, 30, 31). However, while agility has historically been assessed using pre-planned tasks the contemporary view of agility is that changes of direction occur in response to external stimuli such as opponent and/or ball movements (6, 26, 28). Consequently, this evolution has led to the development of several new reactive agility tests (6, 8, 23, 26, 27, 29) which have since confirmed the importance of both decision-making and physical components in successful reactive agility performance (6, 8, 9, 27, 29). However, numerous other physical sub-factors such as leg strength, power and reactive strength are also thought to be involved in the motor component of successful agility performance (3, 17, 32). But, although widely examined using pre-planned agility tasks (1, 7, 17, 19, 20, 22, 25, 34) these specific associations have yet to be considered using reactive agility (28, 34).

Since pre-planned and reactive changes of direction are unique skills (6, 8, 27), with different patterns and magnitude of leg muscle activation (2, 12) results from research using pre-planned tasks are not readily transferable to reactive agility tasks. Therefore, little is known about the common strength factors involved in reactive agility and how they contribute to variability in agility performance. Contributing to this is the fact that strength measures used previously have generally lacked ecological validity when compared to agility movements (3, 24); some examples being bilateral and vertical movements such as countermovement jumps, squat jumps and back squats, often with low stretch-loads (14, 17, 22). In contrast, agility movements typically involve only one leg (3), under high stretch-shortening cycle loads (reactive strength) (27), producing a combination of vertical, horizontal and lateral ground reaction forces (3, 19), yet strength measurements in these planes have rarely been used. Consequently, the nature of the relationship between single-leg strength in non-vertical planes and reactive agility remains largely unknown.

Given the specificity of these agility actions, unilateral drop jumps that involve high stretch-shorten cycle loads, could offer a more valid alternative for examining the nature of any association between reactive strength and agility (28, 34). In particular, unilateral horizontal and lateral jumps, which closely mimic agility actions, might have greater predictive value for reactive agility and thus assist coaches in developing effective strength and conditioning alternatives with which to augment agility training (3). Additionally, the use of unilateral strength movements also affords the opportunity to detect jump and strength asymmetries and investigate any potential functional links with reactive agility performance when pushing off different legs (10). Previously, vertical jump reactive strength asymmetries have mirrored planned agility asymmetries, when the strength differences were large (>10%) (34). However, it is unclear whether (due to greater similarity in the movements) lateral or horizontal jumps would be more sensitive to differences in reactive agility performance between legs. If so, this will provide coaches with a simple test that might provide an insight into functional deficiencies that may mirror agility performance.

Accordingly, this study examined relationships between unilateral vertical, horizontal and lateral jump performance, reactive strength and kinetic variables and reactive agility performance. The movement phase of reactive agility was of particular interest as leg strength is primarily involved during that component, rather than the decision-making phase. In addition, since the reactive agility protocol used in this study was specifically designed to ensure the movements were conducted at very high intensities (8) (as expected during most sports) the physical loads experienced closely represented those expected of a sport-specific agility task. Accordingly, it was predicted that a strong association between jump performance, kinetic variables and agility performance would be observed but that the strongest association would be for the lateral jumps. However, it was also expected that (collectively) these three jumps would explain much of the variance in agility performance, as agility actions are thought to involve a combination of these movements (3, 19).

Also, it was anticipated that asymmetries between the legs during the jump tests would mirror functional differences in agility performance when pushing off each leg and that the lateral jumps would demonstrate the greatest sensitivity, again due to the similarity between the movements (i.e. small differences in jump ability would predict differences in agility time). Finally, it was predicted that after dividing the whole group into faster and slower sub-groups (based on reactive agility movement times) that any differences in agility performance between the sub-groups would be accompanied by concomitant differences in jump ability on all jumps, but that the greatest difference would be observed in the lateral jumps, due to the common strength factors involved in these movements. Consequently, this study aimed to provide an insight into the relative effectiveness of different single-leg jump tests as predictors of reactive agility, ability and symmetry. This should assist coaches to develop guidelines for agility training; specifically, whether lateral or other non-vertical unilateral strength and power exercises may augment existing agility training programs.

METHODS

Experimental Approach to the Problem

This study investigated the relationship between performance on three different unilateral jumps and reactive agility. Specifically, the jumps involved three variations of a unilateral leg power test (24) and a video-based reactive agility test developed and validated previously in Australian footballers (8). The jump task required a horizontal jump forward a distance equal to 120% of individual leg length onto one leg and then immediately for maximum vertical height or horizontal or lateral (>45°) distance. Mean agility and movement times, jump performances, reactive strength indices and various kinetic variables were compared with each other and between the dominant and non-dominant legs, and also for faster and slower agility performers. This allowed an assessment of which jump best predicts agility movement performance, detects any functional agility asymmetries, and provided information on the role of multi-directional reactive strength in agility performance.

Subjects

An a priori power analysis (GPower V3.0.1, Dusseldorf, Germany) revealed a sample size of 26 would result in statistical power of 0.80 at an alpha level of 0.50 and an effect size of r = 0.5. Therefore, to allow for drop-out, 31 trained males with a recent (within 2 years) involvement in Australian Rules football were recruited for this study (mean ± SD age, height and mass of 29 ± 5 years, 181 ± 6 cm and 83 ± 8 kg respectively). The Human Ethics Committee of The University of Western Australia approved the study design and subjects were informed of the risks and subsequently gave informed consent.

Procedures

All testing was conducted on a carpeted sprung wooden floor and in the morning (during the summer pre-season period for those subjects still playing) and all wore rubber soled sports shoes and light athletic clothing. All subjects were asked to refrain from strenuous exercise the day prior to the test session, not to consume caffeinated drinks on the day of the testing or eat within 2 hours of the session. However, they were encouraged to drink water upon arriving and during the warm-up to ensure they were well hydrated. During the first test session, height, mass and leg length, measured from the superior aspect of the greater trochanter of the femur to the floor, were measured (16). After a 10-minute standardized warm-up, three maximal 4 m linear sprints were completed, with a 90-second recovery between each, with the fastest time later used to manipulate stimulus duration during the reactive agility test. After another 5-minute recovery the three (vertical, horizontal and lateral) jumps were described, demonstrated and practiced until subjects successfully completed five on each leg for each jump. The video-based reactive agility test was then explained and demonstrated and subjects completed eight sub-maximal practice trials, including 3 turns each to the left and right and two with no turn.

In the second testing session subjects completed three practice trials of each jump and after a five-minute recovery, the 18 experimental jumps were completed. The experimental jumps included three jump variations in which subjects started with two feet together at a point measured from the front edge of a 40x30cm square marked on a force platform (AMTI, Watertown, Massachusetts). The distance of that point from the front edge of the square was equal to 120% of their individual leg length (e.g. leg length = 930 cm, start point = 1116 cm). The subjects then jumped forward on to one foot on the force platform within the marked square and immediately upon landing (minimizing ground contact time) then jumped for maximum horizontal or lateral distance or height, to then land again on two feet. Using this approach, the three variations of jumps were to jump forward (HJ), jump laterally at a 45° angle (LJ) and to jump vertically (VJ). Three trials of each jump off each leg were completed with 90 s recovery in between, and the mean of the best two jumps was used for analysis. The reliability of the horizontal jump test has been previously established (24).

After a 5-minute rest period, three reactive agility familiarization trials were completed, then after another 5-minute rest, ten experimental reactive agility trials were performed, including three turns to the left and right, one dummy turn each to the left and the right and two with no turn, with 90 seconds recovery between each trial. The design of the reactive agility test (Figure 1) has been detailed elsewhere (8) but, briefly subjects sprinted forward 3-4 m whilst watching a life-sized projection of another player who is running away and who then turns left or right. The subject must react as quickly and accurately as possible to also turn and sprint through exit gates, simulating a chase to tackle scenario. Previously, this protocol was found to have good test-retest (co-efficient of variation of 1.4% and intra-class correlation coefficient of 0.81) and intra-rater reliability (co-efficient of variation of 5.2% and intra-class correlation coefficient of 0.99) (8, 9).

** Figure 1 about here **

Data collection and analysis

Jump Trials

A 100 Hz Basler video camera (A602fc, Basler Vision Technologies, Ahrensberg, Germany) placed perpendicular to the jump path captured footage to determine distance in the lateral and horizontal jumps. This was achieved using siliconCOACH PRO™ V6 software (Dunedin, New Zealand) to first obtain a scale factor from reference marks placed on the floor where the subjects were jumping. Subsequently, these were used to measure the distance from the toe of the take-off foot to heel of the rearmost foot upon landing (± 0.01 m), whereas vertical jump height was determined from flight time using the equation (15):

$$(9.81 \times \text{flight time}^2)/8$$

Kinetic data was collected using an AMTI force plate (AMTI, Watertown, Massachusetts), sampling at 2000 Hz connected to a video camera, and a computer running Vicon Nexus (V1.7) software (Vicon, Oxford, United Kingdom). Ground reaction force data was filtered using a fourth order, dual pass Butterworth filter with a cut-off frequency of 30 Hz and the forces (F) described relative to the force plate where Fx was medio-lateral, Fy anterior/posterior and Fz vertical. A customized MatLab (MathWorks, Natick, Massachusetts) software program analyzed the force data, which was subsequently normalized to the body mass of each subject.

In addition to jump distance and height, total ground contact time, reactive strength index (RSI) (jump height or distance divided by total ground contact time)

(18), mean ground reaction force and peak push-off ground reaction force in each of the three planes were calculated. Using the jump distance or height, the best two trials were identified and mean values for the above kinetic variables used for analysis.

Agility Trials

A 100 Hz Basler camera (A602fc, Basler Vision Technologies, Ahrensberg, Germany) positioned 4 m behind the start line recorded the agility trials, and by using siliconCOACH PRO™ V6 software (Dunedin, New Zealand) combined with infra-red timing gates (Fitness Technology, Adelaide, Australia), the following times were recorded (±5 ms):

1. *3 m time* – from start gate to abort gate (at the 3 m mark).
2. *Total Time* – from start gate to exit gate.
3. *Agility Time* – total time minus 3 m time.
4. *Movement Time* – from the subjects' response initiation until passing through an exit gate.

Finally, subjects were also ranked based on the mean movement time during the agility test and divided into faster (fastest 15) and slower (slowest 15) agility sub-groups. Also, leg dominance was determined based on the preferred kicking leg of each subject.

Statistical Analysis

Differences in jump and agility performance between the dominant and non-dominant legs were assessed using dependent t-tests while independent t-tests were used to compare the faster and slower agility sub-groups, with an alpha level of $p < 0.05$ applied for both. Cohen's effect sizes (*d*) were also calculated and interpreted based on the criteria of Hopkins (11), where >0.0 = trivial, ≥0.2 = small, ≥0.6 = moderate, ≥1.2 = large, ≥2.0 = very large, ≥4.0 = nearly perfect. Pearson correlations (r) were used to determine relationships between jump variables and agility movement times and were interpreted based on the criteria of Hopkins (11) whereby 0 - 0.1 = trivial, 0.11 – 0.3 = small, 0.31 – 0.5 = moderate, 0.51 – 0.7 = large, 0.71 – 0.9 = very large, 0.91 – 0.99 = nearly perfect, 1=perfect. Standard linear regression analysis was used to estimate the contribution of combined jump performances as predictor variables for reactive agility variance. Initially, since lateral jumps were predicted to have the strongest influence this was entered alone at Step 1 and then performance on the other two jumps were added at Step 2 to assess the additional contribution of these variables to explaining agility variance (R^2). Standardized beta co-efficient's were used to establish the contribution of each jump to the predictor model with $p < 0.05$ considered significant.

RESULTS

Mean, standard deviation and Pearson correlations for pooled agility and movement times and the lateral, horizontal and vertical jumps are presented in Table 1. The correlations between the jumps were large or very large (r = -0.62 to -0.77) but were weaker when compared to agility movement performance, with the highest correlation of -0.33 (p = 0.07) between vertical jump height and movement time. Similarly, Table 2 presents the kinetic data and the correlations between agility and movement times. The association between pooled kinetic variables and movement time were typically weak, with the highest association being with horizontal jump mean vertical force output (Fz) (r = 0.32; p = 0.08). However, this correlation shows that as the force output increased movement time also increased (worsened). The highest negative correlation (indicating a faster movement time) was between lateral jump peak lateral force output (Fx) (r = -0.26), but this was also weak. The correlations between the vertical mean and peak force on all the jumps and agility time were somewhat stronger and significant, but the co-efficient of variation indicates the associations were not particularly strong (r^2 = <24%).

** Tables 1 and 2 about here **

Table 3 presents the standardized (β) and un-standardized beta co-efficients (*B*), standard error of the beta co-efficient and p values for lateral jumps and the model as a whole. The total variance in agility movement performance explained by lateral jump was R^2 = 6%, $F(1, 29) = 1.92$, p = 0.17. After entering vertical and horizontal jumps into the model at Step 2 the variance explained by the model as a whole increased (R^2 change) by 5% to a total of 11%, $F(3, 27) = 1.15$, $p = 0.35$. Therefore, collectively the jumps explain a relatively minor amount of the total variance of agility movement time.

** Table 3 about here **

Table 4 illustrates the differences in agility and jump performance (distance and reactive strength index) when pushing off the dominant and non-dominant legs. Both agility (difference = 5.4 %; $p < 0.001$; $d = 0.84$) and movement times (5.6 %; $p = 0.004$; $d = 0.86$) were significantly faster when turning off the dominant leg. Similarly, subjects jumped significantly further (3%; $p = 0.008$; $d = 0.35$), with a higher reactive strength index (4.4%; $p = 0.03$; $d = 0.28$) using the dominant leg during lateral jumps. In contrast, subjects jumped slightly further or higher using the non-dominant leg during the horizontal (1.8%; $p = 0.09$; $d = 0.2$) and vertical jumps (6.9%; $p = 0.12$; $d = 0.26$). But, no significant differences in any kinetic variables between the legs on any jump were found and correlations between kinetic variables and reactive agility performance were moderate (r < -0.44).

** Table 4 about here**

Table 5 illustrates agility and movement times, jump performance and reactive strength indices in faster (n = 15) and slower (n = 15) agility sub-groups. Compared to the slower sub-group the faster sub-group had significantly faster movement times (7.1%; $p < 0.001$; $d = 2.0$) but there were no other differences and only small to trivial effect sizes observed in jump performance and kinetic variables.

** Table 5 about here**

DISCUSSION

The association between reactive strength and reactive agility has yet to be clearly established (3), so we examined this by comparing unilateral vertical, horizontal and lateral jump performance with performance on a video-based reactive agility test (8). The jumps chosen were considered a good measure of reactive strength under fast stretch-shorten cycle loading (24), which is the type of strength considered important in agility tasks (27, 28, 32). Additionally, modifying traditional single-leg drop-jumps to include jumps in multiple directions also more closely mimics the agility tasks, which also predominantly involve single-leg lateral and horizontal actions (3).

Correlations between performance on the various jumps were moderate to very large, with the strongest relationship between lateral and horizontal jumps, which indicates some commonality between the skill and strength requirements for the different jumps. However, the relationship between performance and kinetic variables on each of the jumps and reactive agility movement time were weak, with vertical jumps showing the strongest association. Therefore, these results do not support our hypothesis that lateral jumps would exhibit the strongest relationship due to the similarity of the movements and strength requirements. In addition, regression analysis also showed that collectively all the jumps explained only 11% of the variance in agility movement time, also contradicting our previous prediction.

Therefore, leg strength as measured by unilateral drop jump has limited predictive value in relation to the motor component of reactive agility performance, similar to that observed in previous research using pre-planned agility (19). Accordingly, strength does not seem to be an important contributor to agility movement performance, and other skill-based factors may play a larger role (3, 19, 22, 33).

It is also believed that athletes will generally turn faster off their dominant or stronger leg (5, 19, 34) and that any asymmetries in jump performance between the dominant and non-dominant legs will be reflected in agility movement times using the different legs. Our results did provide some support for this hypothesis since those subjects who had faster movement times when pushing off their dominant leg also jumped significantly further laterally, with a higher reactive strength index using that leg. Yet, in contrast, the horizontal and vertical jumps were slightly better using the non-dominant leg. Therefore, superior reactive agility is associated with a concomitant advantage in jumping ability and potentially the reactive strength in the dominant leg, but only when applied laterally, likely due to the similarity between the skills and actions in each of these tasks.

That superior vertical jump ability in the non-dominant leg did not result in enhanced performance is at odds with previous research reporting that vertical drop jump asymmetries also mirror (planned) agility asymmetries (34). However, it is believed that the discrepancy in vertical jump height may need to be large (>10%) (5, 34) before any differences in agility are noted, as vertically applied force may play a lesser role than lateral force production. Our results support this notion, since a 7 % advantage in vertical jump height using the non-dominant leg (less than the 10% threshold) was not accompanied by a better movement time using that leg; indeed, subjects were slower when turning off that leg. In contrast, a 3% advantage in lateral jump distance was associated with a 5.5% difference in reactive agility movement time, in accordance with our hypothesis that the lateral jumps are more sensitive to differences in agility movement ability. However, since asymmetries of approximately 8% are considered common in jump assessments in normal athletic populations (4, 21), the similarity between lateral jump and agility asymmetries seen here might simply be coincidental rather than functionally linked, a view supported by the weak correlations. Nevertheless, coaches seeking diagnostic tools with which to identify functional weaknesses in athlete agility profiles should still consider single-leg lateral jump tests in preference to vertical jumps, although the overall role of reactive strength in complex agility tasks may still be limited (3, 13).

After dividing the subjects into faster and slower agility sub-groups, no significant differences in jump performance were found and so our hypothesis that such an association would occur is rejected. Therefore, the factors involved in producing asymmetrical jump performance between the legs do not appear to be important in producing more agile athletes overall. Additionally, the lack of differences in reactive strength and kinetic variables recorded between the faster and slower movement time groups also support the notion that factors other than reactive strength may be involved in specific reactive agility performance. Therefore, although jump assessments appear to have limited capacity to predict reactive agility performance (19), there is evidence that there are potentially some common, non-strength, factors involved in producing asymmetries in single-leg lateral jumps and reactive agility. Accordingly, lateral jumps could provide an insight into functional imbalances that, even when small, might mirror meaningful differences in agility performance.

Nonetheless, it is unlikely that one characteristic alone is responsible for either agility or unilateral jump success. Indeed, overall reactive agility performance will be largely influenced by cognitive and decision-making factors rather than the motor component (6, 8, 9, 27) and when specifically considering motor component of agility factors such as skill, balance, stability and coordination, are likely to play a more significant role in performance than strength (17, 30, 34). Therefore, a context-specific task-based approach to agility training would seem to offer the most potential for maximizing agility performance (13).

PRACTICAL APPLICATIONS

Including single-leg lateral jumps in a test battery will help coaches identify potential asymmetries in leg strength, which may reflect both the motor component of reactive agility and overall performance. This will provide a greater understanding of the agility profile of athletes and allow for the development of more specific training regimes. However, since measuring jump kinetics offers little extra information, only distance and reactive strength index need to be measured. Coaches should also recognize that reactive strength appears to play a limited role in reactive agility performance and that numerous other non-strength factors (e.g. skill, balance) are likely to be more important. Therefore, sports-specific reactive agility tasks and scenarios should be the cornerstone of agility-training regimes.

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Figure Legends

Figure 1. Schematic illustration of the video reactive agility test (8, 9)

Table 1: Mean ± SD performance values and correlations between agility and movement times and lateral, horizontal and vertical jumps.

Table 2: Mean ± SD lateral, horizontal and vertical jump kinetic variables and correlations between agility and movement times (n = 31).

Table 3: Multiple regression unstandardized beta co-efficients (*B*), standard error of *B*, standardized co-efficients (β) and p values for lateral jump performance (Step 1) and lateral jump combined with horizontal and vertical jumps (Step 2) (n=31).

Table 4: Mean ± SD performance values and differences in agility and movement times and lateral, horizontal and vertical jumps when pushing off using the dominant and non-dominant legs.

Table 5: Mean ± SD and differences between faster and slower agility groups[a] on agility and movement times and lateral, horizontal and vertical jump distance/height and reactive strength index (RSI).

Table 1: Mean ± SD and correlations between agility and movement times and lateral, horizontal and vertical jumps.

	Mean ± SD (n=31)	Correlation co-efficient				
		Agility time	Movement time	Lateral jump	Horizontal jump	Vertical jump
Agility time (s)	1.48±0.07	1				
Movement time (s)	1.03±0.05	0.37†	1			
Lateral jump (cm)	205±15	-0.12	-0.25	1		
Horizontal jump (cm)	225±18	-0.15	-0.29	-0.77††	1	
Vertical jump (cm)	30±4	-0.28	-0.33	-0.62††	-0.74††	1

† = $p < 0.05$; †† = $p < 0.001$ - Correlation significant

Table 2: Mean ± SD lateral, horizontal and vertical jump kinetic variables and correlations between agility and movement times (n=31).

	Lateral Jump			Horizontal jump			Vertical Jump		
	Result	Agility Time Correlation	Movement Time Correlation	Result	Agility Time Correlation	Movement Time Correlation	Result	Agility Time Correlation	Movement Time Correlation
Mean Fz (bw)	**-18.1±1.4**	0.43†	0.22	**-17.9±1.2**	0.40†	0.32	**-19.7±3.5**	0.40†	-0.13
Peak Fz (bw)	**-24.7±2.4**	0.45†	0.21	**-25.0±2.5**	0.48†	0.27	**-25.9±5.1**	0.38†	-0.14
Mean Fy (bw)	**-0.1±0.4**	-0.16	-0.07	**2.8±0.6**	-0.28	0.14	**-4.1±0.8**	0.24	-0.15
Peak (push off) Fy (bw)	**2.3±0.4**	-0.01	-0.11	**5.4±0.8**	-0.10	0.21	**0.6±0.7**	-0.26	-0.09
Minimum (braking) Fy (bw)	**-3.3±1.0**	0.02	-0.17	**-0.9±0.6**	-0.06	-0.07	**-6.1±1.3**	0.35	-0.11
Mean Fx (bw)	**5.4±0.7**	-0.24	-0.14	**-0.1±0.2**	-0.04	0.08	**-0.2±-.2**	0.25	0.23
Peak Fx (bw)	**7.7±1.2**	-0.21	-0.26	**N/A**	-0.23	-0.11	N/A	-0.05	0.27

bw = normalized to body weight N/A = not available

† = p < 0.05; †† = p < 0.001 - Correlation significant

Table 3: Multiple regression unstandardized beta co-efficients (*B*), standard error of *B*, standardized co-efficients (β) and p values for lateral jump performance (Step 1) and lateral jump combined with horizontal and vertical jumps (Step 2) (n=31).

	B	**SE *B***	β	***p***
Step 1				
(constant)	1208.84	126.9		
Lateral jump	-0.86	0.62	-0.25	0.17
Step 2				
(constant)	1204.63	138.95		
Lateral jump	-0.11	0.98	-0.03	0.91
Horizontal jump	-0.28	0.99	-0.09	0.78
Vertical jump	-2.91	3.31	-0.24	0.39

Note: R^2 = .06 for Step 1, Δ R^2 = .05 for Step 2 ($p > 0.05$)

Table 4: Mean ± SD and differences in agility and movement times and lateral, horizontal and vertical jumps when pushing off using the dominant and non-dominant legs.

	Dominant leg push-off (n=31)	Non-dominant leg push-off (n=31)	p value	Percent difference	Effect size (qualitative descriptor)
Agility time (s)	1.48±0.07	1.56±0.12	<0.001††	5.4	0.84 (moderate)
Movement time (s)	1.06±0.06	1.12±0.08	0.004†	5.6	0.86 (moderate)
LJ distance (cm)	208±16	202±15	0.008†	3.0	0.35 (small)
LJ RSI ($cm \cdot s^{-1}$)	595±96	570±83	0.03†	4.4	0.28 (small)
HJ distance (cm)	223±18	227±19	0.09	1.8	0.2 (small)
HJ RSI ($cm \cdot s^{-1}$)	663±101	679±88	0.25	2.4	0.16 (trivial)
VJ distance (cm)	29±4	31±5	0.12	6.9	0.26 (small)
VJ RSI ($cm \cdot s^{-1}$)	84±16	89±19	0.14	5.9	0.28 (small)

† ($p < 0.05$); †† ($p < 0.001$): Dominant leg better than the non-dominant; LJ = lateral jump; HJ = horizontal jump; VJ = vertical jump; RSI = reactive strength index

Table 5: Mean ± SD and differences between faster and slower agility groups[a] on agility and movement times and lateral, horizontal and vertical jump distance/height and reactive strength index (RSI).

	Faster Group (n=15)	Slower Group (n=15)	p value	Percent difference	Effect size (qualitative descriptor)
Agility time (s)	1.47±0.07	1.48±0.07	0.60	0.6	0.14 (trivial)
Movement time (s)	0.99±0.02	1.06±0.05	<0.001††	7.1	2.0 (very large)
Lateral jump distance (cm)	207±14	204±17	0.59	1.5	0.19 (trivial)
Lateral jump RSI ($cm \cdot s^{-1}$)	586±44	579±54	0.71	1.2	0.14 (trivial)
Horizontal jump distance (cm)	230±16	220±19	0.19	4.5	0.57 (small)
Horizontal jump RSI ($cm \cdot s^{-1}$)	682±62	660±68	0.35	3.3	0.34 (small)
Vertical jump distance (cm)	31±5	29±4	0.27	6.8	0.44 (small)
Vertical jump RSI ($cm \cdot s^{-1}$)	89±17	83±15	0.34	7.2	0.37 (small)

[a] Faster group was the 15 participants with the fastest mean movement times during the agility test. The slower group were the 15 with the slowest movement times

†† (p < 0.001): Faster group better than slower group

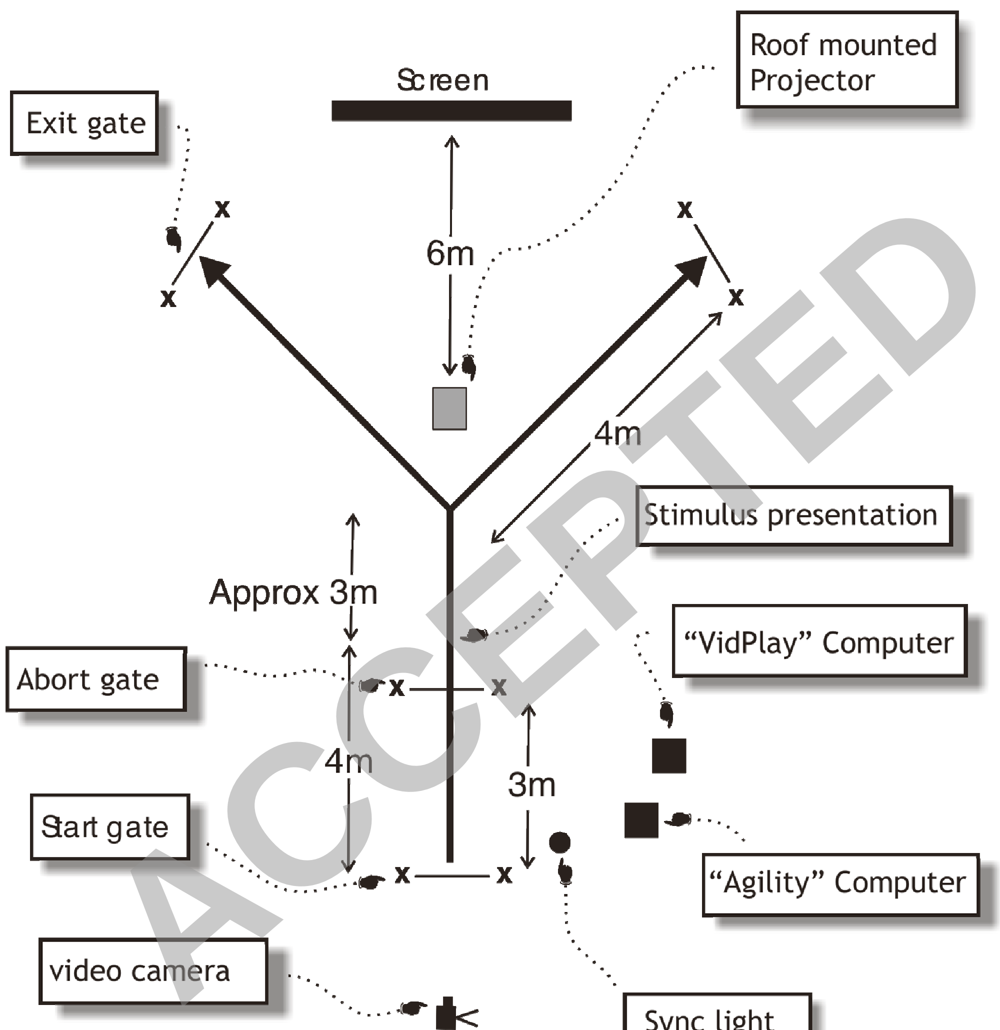

Figure 1. Schematic illustration of the video reactive agility test.